Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM027-P01 Room:Convention Hall Time:May 25 10:30-13:00

Roles of magnetic reconenction induced by the Kelvin-Helmholtz vortex in the solar wind entry into the magnetosphere

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We have performed two and half dimensional full particle simulations of the MHD-scale Kelvin-Helmholtz vortex (KHV). The KHV has been believed to cause direct entry of the solar wind plasma into the magnetosphere across the low-latitude magnetopause under northward IMF conditions. Indeed, KHVs have been frequently observed around the low-latitude magnetopause when the IMF is northward. In order to understand the precise solar wind entry mechanism related with the KHV, a number of numerical simulations have been performed. Nevertheless, there is still no comprehensive understanding of the actual entry mechanism. Since the size of the observed KHVs is of MHD-scale, it may be expected that the behavior of the KHV can be described by the ideal-MHD equations. In the ideal-MHD, however, the frozen-in condition does not allow plasmas to be transported across the magnetic boundary. This indicates that non-ideal MHD effects should be considered to truly understand the actual entry mechanism. Fortunately, recent developments of computer resources allow non-ideal MHD simulations of the MHD-scale KHV to be performed. Such simulations have revealed that magnetic reconnection induced by the KHV can cause the effective solar-wind entry along reconnected field lines. Furthermore, our particle simulations are quantitatively confirming the actual entry rate of the solar-wind plasma via the vortex-induced reconnection. In this presentation, we will present the particle simulation results and discuss how important the KHV is in the solar wind entry into the magnetosphere.

Keywords: Kelvin-Helmholtz, solar wind entry, magnetic reconnection, particle simulation, plasma mixing, magnetic island

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PEM027-P02 Room:Convention Hall Time:May 25 10:30-13:00

Statistical analysis of LH plasma waves observed by Geotail spacecraft

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In this study, we make analysis on generation conditions of LH plasma waves observed by Electric Field Detector (EFD) onboard Geotail spacecraft. We detected LH plasma waves automatically from EFD data, and made an occurrence frequency distribution of LH plasma waves.

LH plasma waves are observed in Lobe region and PSBL region in the magnetosphere. We studied several plasma parameters at the time when LH waves were observed. We found that LH waves were observed with the large perpendicular velocity of ion and the earthward ion flow. In addition, the LH plasma waves observed with the earthward ion flow have low frequencies, and the strengths of those LH plasma waves are relatively large. Figure 1 shows the spatial distribution of the point where LH plasma waves were observed by Geotail spacecraft. Red, blue and light blue points show LH plasma waves observed in Lobe, PSBL and other regions, respectively. These results suggest that strong LH plasma waves are observed in the boundary region where ion flow usually exist, such as Lobe region close to PSBL. In addition, LH plasma waves are observed when ion velocity perpendicular to the ambient magnetic field is enhanced and earthward ion flows are observed. We will farther investigate the occurrence conditions of LH plasma waves to clarify the generation mechanism of these waves and their effects on local plasma environment in the magnetosphere.

Keywords: Lower Hybrid plasma wave, magnetosphere, statistical analysis, ion flow, wave-particle interaction

Japan Geoscience Union Meeting 2011
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PEM027-P03 Room:Convention Hall Time:May 25 10:30-13:00

Contribution of kinetic Alfven waves to the formation of the low-latitude boundary layer

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One of the biggest problems in magnetospheric physics is to understanding how the solar wind plasma enters the magnetosphere and forms the low-latitude boundary layer (LLBL) during northward interplanetary magnetic field periods. Several processes have been suggested including: (1) magnetic reconnection at the poleward-of-the-cusp in both hemispheres, (2) reconnection or turbulence within well-developed Kelvin Helmholtz vortices on the flank magnetopause, and (3) diffusive transport induced by wave-particles interactions.

Regarding the third process, we revealed from test particle simulations that transverse and compressional fluctuations via kinetic Alfven waves (KAWs) can cause selective transport associated with their perpendicular wavelengths. Applying the results to a magnetopause crossing event in which the existence of the KAWs had been identified, we successfully found that KAWs can actually transport solar wind plasma across the magnetopause. In this presentation, we will show applications to various magnetopause-crossing events and discuss whether the KAWs can contribute to the formation of the LLBL.

Keywords: low latitude boundary layer, plasma wave, kinetic Alfven wave, reconnection, plasma transport

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PEM027-P04 Room:Convention Hall Time:May 25 10:30-13:00

Statistical visualization of the Earth's magnetosphere with THEMIS probe data

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In this study, we have visualized the averaged structure of Earth's magnetosphere using the magnetic field and plasma data obtained by THEMIS probes during the interval from August 2007 to October 2010. An advantage of using the THEMIS data is that they give us a clear picture of the Earth's magnetosphere including various boundaries.

This is due to the following characteristics:

(1) Five THEMIS probes cover large areas around the Earth up to 30 R_E (R_E: one Earth radius), and they offer large amount of data.

(2) The interval of the observations (2007-2010) is relatively short and the solar activity is low during its time period, so that we can expect that the data were obtained under uniform conditions.

First, we distributed THEMIS data on the X-Y plane with the GSM coordinate system. Then we separated the plane into the bins with $1R_E * 1R_E$ (R_E: Earth radius) size. Finally, we calculated averaged values of the parameters such as density, temperature, three-components of velocity for ions and electrons, as well as three-components of magnetic field in each bin, and we displayed them with color code. Employing this method, we could visualize the Earth's magnetosphere which composed of the bow shock, magnetosheath, magnetopause etc.

We further discuss the following two points based on the obtained results.

(1) Comparison between our results and the results of previous models of the magnetosphere (such as Shue et al.'s model [1997], and Peredo et al.'s model [1995])

(2) Variations in the magnetospheric structures and the plasma transport to the change of the solar wind dynamic pressure change or to the occurrence of magnetic storms

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PEM027-P05 Room:Convention Hall Time:May 25 10:30-13:00

Reconstruction of quasi-static plasma structures in spacetime from in-situ measurements

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Even after the advent of multi-spacecraft missions such as Cluster and THEMIS, it has been difficult to distinguish between spatial and temporal variations from in situ measurements. This is partly because most data analysis methods do not accommodate both features. For example, the original version of Grad-Shafranov (GS) reconstruction (Sonnerup and Guo, 1996; Hau and Sonnerup, 1999), the method for recovering two-dimensional magnetohydrostatic structures from in situ measurements, assumes that the structures are time independent (as seen in a proper frame of reference) over the interval to which the method is applied. However, actual structures may be evolving, even if slowly, during that interval. We present a novel method for reconstructing such slow evolution of quasi-static structures (Hasegawa et al., 2010), which is an extension of the original GS method. The method is tested by use of synthetic data from numerical simulations of time-dependent magnetic reconnection, and the results from application to Cluster observations of a flux transfer event at the dayside magnetopause are presented. We also show that multipoint information allows for the size of the reconstruction domain to be increased, and for proper estimation of the orientation of the invariant axis, along which gradients are assumed to be negligible.

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Hau, L.-N., and B. U. O. Sonnerup (1999), J. Geophys. Res., 104, 6899-6917.
Sonnerup, B. U. O., and M. Guo (1996), Geophys. Res. Lett., 23, 3679-3682.

Keywords: Grad-Shafranov equation, magnetopause, magnetohydrostatic equilibrium, magnetic reconnection, data analysis method

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PEM027-P06 Room:Convention Hall Time:May 25 10:30-13:00

Response of the Earth's magnetosphere to change of IMF Bz component

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It is known that plasma energy is transported from the solar wind to the Earth's magnetosphere, and IMF Bz component plays the most important role in the transportation through magnetic reconnection. Thus, it became clear that large magnetic storms in the magnetosphere are caused by CME with a southward IMF.

In contrast, high-energy electrons in the Earth's outer radiation belt are due to CIR (Co-rotating Interaction Region) which doesn't cause strong magnetic storms in contrast with CME. The characteristics of CIR are long duration of high-speed solar wind and fluctuations of IMF.

Thus we have executed a 3-dimensional global MHD simulation between the solar wind and earth's magnetosphere in order to study response of the magnetosphere to oscillations of the IMF Bz component. The configuration and dynamics of the magnetosphere depending on oscillations of the IMF are demonstrated.

Keywords: MHD, IMF, CIR

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PEM027-P07 Room:Convention Hall Time:May 25 10:30-13:00

Reciprocal ionospheric convection cells during northward interplanetary magnetic field periods

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It is known that the dayside ionospheric convection at small interplanetary magnetic field (IMF) clock angles (less than or equivalent to 30 degrees) exhibits twin reverse cells in both hemispheres. Traditionally, this convection pattern has been interpreted in terms of lobe cells circulating in the open field line region of the ionosphere. Recently, the lead author has shown a flaw of this conventional view and suggested the existence of a new magnetic flux circulation mode that involves reconnection between open and closed field lines. This circulation mode is termed the interchange cycle. A consequence of the interchange cycle is the appearance of a reverse cell circulating in the closed field line region. This convection cell is called reciprocal cells. The reciprocal is unique to the interchange cycle and can be used as an identifier of the circulation mode. The lead author has also shown a "proof of existence" of the ionospheric situation that is expected for the interchange cycle. However, an observational approach is always subject to various limitations. For example, determining the open-closed field line boundary is suggestive but not definitive. The purpose of this paper is to check whether global magnetohydrodynamic (MHD) simulations can reproduce reciprocal cells as observed, to further support the existence of the interchange cycle. For this purpose, we performed several simulation runs, changing IMF clock angles. We found that MHD simulations could reproduce reciprocal cells qualitatively, but the reproduction was not perfect quantitatively. For example, the reciprocal cell intensity (potential drop) was much smaller than the observations. In this paper, we compare simulation results with observations in various aspects and discuss their differences.

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PEM027-P08 Room:Convention Hall Time:May 25 10:30-13:00

Reproducing substorm-related changes of the near-Earth magnetotail field structure in a global MHD simulation

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We reproduce the magnetospheric reconfiguration under a southward and duskward interplanetary magnetic field (IMF) condition by a numerical magnetohydrodynamics (MHD) simulation.

To investigate the relative displacements of the geomagnetic conjugate points, we trace both footprints of the geomagnetic field lines during the magnetospheric reconfiguration under positive and negative IMF By conditions. Several substorm-like features, namely the formation of a near Earth neutral line, fast Earthward flows and tailward release of the plasmoid, occur about 1 hour after southward turning of the IMF. The field line traced from the near-Earth magnetotail was strongly distorted toward dusk (dawn) in the north and toward dawn (dusk) in the south after the substorm onset under the positive (negative) IMF By conditions. The maximum relative displacement in the longitudinal direction of both footprints is 4.5 (5.5) hours in magnetic local time for the positive (negative) IMF By case.

While observational studies have indicated that the IMF orientation is the main controlling factor of the relative displacement of the conjugate points, this simulation study with constant IMF orientation shows that the substorm-related magnetic field variations and the field aligned currents (FACs) are likely to play a major role.

Keywords: aurora, substorm

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PEM027-P09 Room:Convention Hall Time:May 25 10:30-13:00

Eigenfrequency of geomagnetic field line in a global MHD simulation

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Shear Alfven waves propagating along the geomagnetic field line form standing waves along filed line. The magnetic field intensity and the plasma mass density affect the velocity of shear Alfven waves. Thus temporal and latitudinal variations in the field-line eigenfrequency are potentially caused by variations in the field-line length, the magnetic field intensity, and the mass density along the field line.

We estimated the eigenfrequency by numerically solving the standing Alfven wave equation along the geomagnetic field in a global MHD simulation. The magnitude of diurnal variation in the eigenfrequency becomes larger according as the latitude increases. In low latitudes, the eigenfrequency agrees with that estimated with empirical magnetospheric model (TS04). However, in high latitudes, the rate of variability estimated in a global MHD simulation is larger than the empirically-based assessment.

In this study, we compared the diurnal variations in the eigenfrequencies observed at the vicinity of Syowa Station, Antarctica, and Dunedin, New Zealand with the estimated eigenfrequencies. We found that the global MHD simulation is adequate to reproduce variations in the eigenfrequency at dawn and dusk. The geomagnetic field lines started are extend toward the night sector.

These distorted field lines are not adequately reproduced by the empirical models.

PEM027-P10 Room:Convention Hall Time:May 25 10:30-13:00

Activity of ECH waves near the equatorial magnetosphere seen by THEMIS: Implications for diffuse auroral emissions

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It has been thought that the source of diffuse auroral emissions is scattered plasma sheet electrons into the loss cone by some wave-particle interactions. Both ECH waves and whistler-mode chorus have been thought to be the contributors to the production of diffuse auroral electrons since they can resonate with plasma sheet electrons. A question which wave mode dominantly contributes to the production of diffuse auroral electrons has been discussed for more than four decades and there is still controversy on the magnetospheric physics. A recent study done by Thorne et al. [2010] reveals that whistler-mode chorus is dominantly responsible for the production of diffuse auroral electrons. While, there are some observational suggestions that ECH waves cause diffuse auroral electron precipitations. [e.g., Nishimura et al., 2010; Liang et al., 2010]. Furthermore, the diffuse auroral electron precipitations derived by Newell et al. [2009] can be observed where no intense chorus emissions are occurred as shown by the THEMIS statistical survey [Li et al., 2009].

The scope of this study is to investigate distributions of average amplitudes of ECH waves near the equatorial magnetosphere in the region of $5 < L < 10$ to consider their role in production of diffuse auroral electrons. This study is an extended work done by Meredith et al. [2009] that investigated ECH wave intensity and occurrence in the region of $4 < L < 7$ near the equator ($|MLAT| < 3$ deg) by the CRRES wave measurements. The THEMIS Filter Bank (FBK) data were used to investigate the ECH wave distributions and the data obtained from June 1 2007 to November 30 2010 were used for the analyses. The magnetic equator is determined from the T89 magnetic field model and the magnetic latitude is also estimated from the ratio of the local magnetic field intensity to the equatorial magnetic field intensity based on the model.

We firstly derived the magnetic latitude distributions of ECH waves and their dependence on the geomagnetic activity. We set selection criteria of ECH emissions since the FBK data have very low frequency resolution which prevent us from determination of wave mode precisely. The results are consistent with the previous study about the latitudinal distributions. The magnetic local time distributions of ECH waves near the equator ($|MLAT| < 3$ deg) were derived using the same selection criteria. The derived magnetic local time distributions showed that ECH waves are observed at higher L-shells ($L > 7$) on the night side and the mean amplitudes enhance as geomagnetic activity level increases. Furthermore, as geomagnetic activity level increases, ECH emissions tend to be observed on the dusk side magnetosphere. The regions mentioned above correspond to the region where there are no intense chorus waves [Li et al., 2009] but diffuse auroral electrons are observed by the low altitude satellite measurements [Newell et al., 2009]. This indicates that ECH waves contribute to the production of the diffuse auroral precipitations to some degree. Thus, it is suggested that the spatially combined electron precipitations due to resonant interactions with ECH waves and whistler-mode chorus make the global morphology of diffuse aurora.

Keywords: Diffuse aurora, wave-particle interaction, ECH wave, Whistler-ode chorus, pitch angle scattering, pitch angle diffusion

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PEM027-P11 Room:Convention Hall Time:May 25 10:30-13:00

Characteristics of Pc 4 Range Magnetic Pulsations Observed by ETS-VIII Satellite and MAGDAS/Yap Station

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Pc 4 is a continuous pulsation with a period from 45 to 150 seconds, and Pi 2 is an impulsive pulsation with a period from 40 to 150 seconds (cf. Saito, 1969). In the present paper, we compared magnetic north-south Y-component data obtained from ETS-VIII (Engineering Test Satellite-VIII ; Koga and Obara,2008) satellite (GG Lon.=146, L=6.6) and H-component data at the MAGDAS/Yap station (GG Lat.=9.50, GG Lon.=138.08, GM Lat.=1.49, GM Lon.=209.06, L= 1.00 ; K. Yumoto et al.,2006 and 2007) during one month of April, 2009, in order to clarify wave characteristics of Pc 4 range pulsations observed at the geosynchronous orbit and near its projection point on the surface of the earth. Moreover, we investigated the local time dependence of occurrence of Pc 4 range pulsations with 20 min. shorter and longer durations at the ETS-VIII orbit. The longer duration Pc 4 pulsations were furthermore analyzed to examine the correlation of Pc 4 waveforms between the ETS-VIII satellite and the Yap station on the ground.

The following results were found;

(1) Pc 4 range pulsations with 20 min. longer duration at the ETS-VIII satellite occur frequently around 09 h and 13-16 h local time(LT). The occurrence frequency shows a dawn-dusk asymmetry with a dusk-side peak.

(2) The occurrence distribution of Pc 4 range pulsations with duration less than 20 min. at ETS-VIII shows a similar local time dependence of Pi 2 pulsations observed at the CPMN/GUA station in the nighttime (see Yumoto et al., 2001), where the GUA station is located near the geomagnetic longitude of ETS-VIII.

(3) Pc 4 range pulsations with duration more than 20 min. show an in-phase relation between ETS-VIII and YAP during 09h -15 h LT, while out-of-phase relationship during 16h - 24 h LT.

These observational results suggest that the longer- and shorter-duration Pc 4 range pulsations can be explained by using Pc 4 excited by K-H instability in daytime and Pi 2 during substorm onset in nighttime, respectively.

Keywords: Pc 4, ETS-VIII, MAGDAS, local time dependence, geosynchronous orbit

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PEM027-P12 Room:Convention Hall Time:May 25 10:30-13:00

Auroral surge at poleward edge in the first 10 min intervals of Pi2 onset

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We reported that Pi2 pulsations often observed on the ground and at the geosynchronous altitudes are mostly attributable to the bifurcation of the fast earthward flows. The flows are repeated at Pi2 periodicities and propagated either eastward or westward after the bifurcation (Saka et al., JASTP, 2010). At the same time, the auroral surge associated with the Pi2 was observed at the poleward edge (SGEPSS at Okinawa, 2010).

For auroral events taken at Manitoba, Canada in 24 and 27 Jan 1986, we made the following observations:
(1) The surge propagated either westward or eastward at poleward edge.
(2) The wave polarizations at geosynchronous altitudes were CW / CCW for westward / eastward surge, respectively.
(3) At the equatorward part of the surge, vortex structures though to be caused by the plasma flows at poleward edge were observed.

Based upon these observations, we conclude that:
(1) The surge is the Alfvenic aurora activated by the eastward/westward propagating burst of flows that repeated at the Pi2 periodicities.

Keywords: Pi2 pulsation, substorm, Alfvenic aurora, all-sky image, geosynchronous altitudes

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PEM027-P13 Room:Convention Hall Time:May 25 10:30-13:00

the study of magnetotail fluctuation during substorms

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The Earth's magnetosphere takes energy from the solar wind and stores it as a form of magnetic fields in the magnetotail. However, when it progresses excessively, the energy release takes place suddenly converting the magnetic field energy to the kinetic energy of particles. This phenomenon is called a substorm, but the physical mechanism of the substorm triggering is still remains unsolved.

In this study, we investigate the plasma density, plasma temperature, three components of velocity and magnetic field vectors in the central plasma sheet using the data from the THEMIS probes in order to obtain some clues to understand the substorm triggering. We found earthward flows which accompany the increase of northward magnetic field in the region beyond X ~ -12 R_e about several minute before the auroral breakup, i.e., the substorm onset. However, the occurrence of such flows decreases around X ~ -11 R_e. The occurrence of earthward flows increases again inside the region of X ~ -10 R_e, but the flow becomes more oscillatory and it is also characterized by the increase of the northward magnetic field.

In this presentation, we will discuss on similarities and differences between those two earthward flows.

Keywords: substorm, dipolarization

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PEM027-P14 Room:Convention Hall Time:May 25 10:30-13:00

Three dimensional distribution of magnetic reconnection region in the near-Earth magnetotail

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The positions of magnetic reconnection regions and relationship between geomagnetic substorm and magnetic reconnection have been studied using observations by a lot of satellites and computer simulations.

In these studies, single magnetic reconnection region usually has been assumed. In this study, three dimensional magnetic reconnection regions are studied using several observations of Bursty Bulk Flow events in the magnetotail. In particular, conjunction events by THEMIS and GEOTAIL satellites located at distant points in the dawn-dusk direction are examined in order to study about three dimensional magnetic reconnection regions.

Keywords: Magnetic reconnection, Diffusion region, Multi-satellite observation

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Coordinated observations of PBIs and reconnection signatures in the magnetotail: THEMIS case studies

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Poleward boundary intensifications (PBIs) are nightside auroral disturbances at the poleward boundary of the auroral oval and have been suggested to be the manifestation of nightside reconnection. However, there have been no simultaneous observations of PBIs and nightside reconnection, so that the association between PBIs and the formation of the near-Earth neutral line (NENL: X ˜ -20 to -30 Re) and distant neutral line (DNL: X ˜ -100 Re) is still unclear.

We have performed coordinated observation of PBIs and nightside reconnection, using the THEMIS all-sky imagers (ASIs) and outer spacecraft (THEMIS B and C). In the present study, we present two case studies on 23 February 2009 and 10 March 2010. We focused on enhancements of PBIs in the ionosphere along with fast tailward flows in the magnetotail that were suggested to be originated from the NENL.

On 23 February 2009, THEMIS B and C were located at X ˜ -17 and -23 Re, respectively. In this event, pseudobreakup occurred ˜7 min after the PBI enhancements. Both spacecraft observed fast tailward flows associated with enhancements of the PBI. It suggests that the enhancements of the PBI were closely associated with the formation of the NENL. We found multiple bipolar signatures in the north-south component of a magnetic field during fast tailward flows. The signatures had a few min periods and were associated with periodic enhancements of the PBI. We suggested that the bipolar signatures of Bz represented successive plasmoid releases from a single NENL.

On 10 March 2010, THEMIS C was located at X ˜ -50 Re in the magnetotail, when enhancements of PBIs were detected in the field of view of ASIs. In this event, a substorm was identified at ˜06:17 UT. 20-60 min prior to the onset, enhancements of PBIs were associated with fast earthward flows at X ˜ -50 RE, which were suggested to be originated from the DNL. On the other hand, enhancements of PBIs several min before the onset were associated with plasmoid ejection from the NENL. These results suggested that both NENL and DNL could be the manifestation of PBIs.

Keywords: substorm, reconnection, aurora, poleward boundary intensification, fast flow